Climate Change Education: progress and challenges in secondary education

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ABSTRACT

The objective of this research was to observe climate change education in high school students (15 to 18 years old) in order to visualize possible contributions to the educational approach to this planetary phenomenon. To this end, it defined as a guiding question: How has climate change education been approached in high school students?. This question was resolved by means of a qualitative bibliometric research, for which 23 articles were selected (1992-2022), extracted from the scopus database, on which the documentary analysis was carried out. The results made it possible to visualize the interest of researchers in this topic, as well as the geographical distribution, the participation of universities, research centers, publication trends by year and the topics addressed in this global topic such as climate change and its possibilities from the school and society.

Key words: Climate change, secondary education, environmental phenomenon, bibliometric studies, educational research.

RESUMEN

El objetivo de esta investigación fue observar la educación sobre el cambio climático en estudiantes de secundaria (15 a 18 años) para visualizar posibles aportes al abordaje educativo de este fenómeno planetario. Para ello, se definió como pregunta guía ¿Cómo se ha abordado la educación sobre el cambio climático en los estudiantes de secundaria?. Esta pregunta se resolvió mediante una investigación bibliométrica cualitativa, para la cual se seleccionaron 23 artículos (1992-2022), extraídos de la base de datos Scopus, sobre los cuales se realizó el análisis documental. Los resultados permitieron visualizar el interés de los investigadores en este tema, así como la distribución geográfica, la participación de las universidades, las instituciones de investigación, las tendencias de publicación por año y los temas

abordados en esta temática global como el cambio climático y sus posibilidades desde la escuela y la sociedad.

Palabras clave: Cambio climático, educación superior, fenómeno ambiental, estudios bibliométricos, investigación educativa.

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Introduction[1]

The Intergovernmental Panel on Climate Change (IPCC) states that the main cause of climate change (hereafter CC) is due to anthropogenic activities that have significantly increased greenhouse gas emissions and have positioned it as the main environmental problem to be addressed for society, which can be addressed from environmental education, teaching and understanding of CC (Karpudewan and Mohd, 2017, p. 791).

In analyzing the development of climate change education (hereafter CCE) over the last thirty years, it is worth noting that in the 1990s the genesis of the legal framework emerged in the United Nations Framework Convention on Climate Change (UNFCCC) (1992) and the Kyoto Protocol (1997); for the 2000s the most important event was the adoption in New Delhi of the UNFCCC Article 6 program (2002) and in the 2010s the Doha Work Program (2012) established the importance of developing educational policies and public policies for CCA, which promote climate empowerment actions (Briceño, 2021, pp. 751-754).

It cannot be ignored that from the futuribles and futurables of the identifies the role of the natural associativity of viable ecosystems, for Morales & Aguja, (2022), educational challenges related to political, economic, social, technological, environmental factors are established, which from the OECD as an objective of sustainable development delivers guidelines to the framework of a work plan and global development.

Under this perspective, the education system faces important challenges in the training of citizens, especially young people, who are seen as protagonists in the action and empowerment of CC adaptation and mitigation processes, being key in the development of local resilience of territories (Leckey, et al., 2021, p. 207).

Thus, research in ECC conducted for three decades by Boyes and Stanisstreet (1993), with the aim of knowing the conceptions and ideas of students regarding the greenhouse effect, has been increasing and including other trends such as identifying misconceptions of CC, understanding causes and consequences of this phenomenon, and proposing strategies to mitigate this environmental problem (García-Rodeja Gayoso and Lima De Oliveira, 2012, p. 197).

Knowing the bibliometric status of research on CCE in high school students allows us to identify convergent aspects of interest and to propose educational strategies to contribute to its approach from the optimism present in young people to mitigate the environmental crisis caused by the effects of CC (Monroe et al., 2019, p. 792).

In this sense, the claim and interest of the authors of this research focused on the recognition of research published in a thirty-year observation window (1992-2022) in the category of articles, recognizing the tensions of CCE and the contributions of the education sector to contribute to education, training and awareness of young people in the face of climate change. In this regard (Orduz, Qujano, Marcela, 2020.P 3359-3363) points out that from the 1992 Earth Summit in the international context, CCE was born from environmental education, which in this summit begins its involution and gives entry to education for climate change CCE focused on mitigating the effects of climate change and the achievement of the SDG2030. The firm emergence of CCE took place in 1993.

[1] This article is a product of the doctoral thesis research "Climate Change Education from Secondary Education: A bet to mitigate the environmental crisis in the Colombian Orinoco" (2017-2022), in the Doctorate in Education program of the Universidad Santo Tomás, in the research line Organization, Educational and Knowledge Management (OGEC).

Based on the above, the integral category that supported this research was developed, namely:

Climate literacy: young people's wills and behaviors.

In the 2010s, during the implementation of the Doha Work Program, CCE research in middle school education (hereafter ME), focused on beliefs, opinions and willingness to act on global warming (Chhokar et al., 2011), (Ambusaidi et al., 2012), (Jackson and Pang, 2016), (Lehnert et al., 2019), (Stevenson et al., 2019), conceptions of the greenhouse effect (Shepardson, 2011), diagnosis and correction of misconceptions about CC (Karpudewan et al., 2015) (Easter and Chang, 2015) (Chang et al., 2017).

Faced with the dilemma of knowing the direct relationship between climate literacy, i.e. how educated are young people about climate change, and the ability to act accordingly, attitudes and behaviors tending to adopt actions to mitigate the emission of greenhouse gases (hereinafter GHG) or adapt to the effects of climate change were evidenced, as evidence of this, studies have shown that not necessarily the most informed will act consistently in favor of GHG reduction (Khan et al., 2020) (Lehnert et al., 2019) (Arya and Maul, 2016). This affirmation of the author, is a tension of great validity that ratifies the importance of the position of the human being, as a key fact to abode this climatic phenomenon.

The development of the previous tension, in the countries where the documentations are dated, opened up emerging studies in the 2020s, relating CC to hope and optimism (Ratinen and Uusiautti, 2020), the awareness, confidence and commitment of students to this environmental problem (Leckey et al., 2021), digital transformations towards education 4.0, involving mitigation, causes and effects of CC (Oliveira and De Souza, 2022) and immersion of MS students in university programs to become CC literate and increase opportunities for vulnerable youth to access STEM (Science, Technology, Engineering and Mathematics.) education careers (Zanetell and Schusler, 2022).

Recognizing these perspectives, it was considered essential to characterize educational research on CC and secondary education using a literature review methodology based on documentary analysis. The materials, methods, design and search strategy used for the execution of the study are presented below.

For Portela, Guarnizo, & Poveda (2021), an educational added value arises from how social appropriation invites the development of highly complex analyses, which makes education a model with emerging variables that from the endogenous and exogenous factors of the educational purposes unveils the added value of science.

Materials and methods

This research, among the materials and methods, opted for a literature review based on which the information was systematized with scientific objectivity, from the documentary analysis of high quality and impact academic articles in order to present to the reader the synthesis of the focalized information that was compiled and analyzed with the support of meta-reference tables that cross qualitative variables for interpretation, fulfilling the objective of visualizing the approach to the planetary-CC phenomenon in the MS, Figure 1 presents the general scheme of the methodology implemented.

Figure 1. Research methodology

Source: Own elaboration (2022)

Method and type of research: this research was developed from the qualitative paradigm and was supported by documentary analysis based on a systematic review of articles from high quality

and high impact journals, published in the SCOPUS bibliographic reference database. A bibliographic research was carried out with the aim of providing information on geographic distribution, research centers and universities that have conducted research on CCE, publication trends by year and topics addressed from this environmental problem.

Search strategy: The preliminary search was conducted in Scopus, entering as search thesauri "Climate Change" and "education" (8002 documents) / "Climate Change" and "High education" (706 documents) / "Climate Change" and "Secondary education" (79 documents) and Climate Change" and "Secondary students" (31 documents). The initial search included studies conducted at all educational levels, so the need arose to limit the research to ensure that the studies to be referenced in their participant population included young people belonging to secondary education (10th and 11th grades). Additionally, references and articles recommended by SCOPUS related to the topic were reviewed in order to delimit other possible sources of information.

Inclusion and exclusion criteria for the documentary analysis: Research articles published in the observation window defined in the last thirty years (from 1992 to 2022) were selected due to the genesis of the legal framework for CCE in the UNFCCC in 1992. Articles that were not freely accessible were omitted and studies whose target population belonged to a level other than secondary education were eliminated. Subsequently, the SCImago Journal Rank indicator was used to verify that the publication journals were classified in the Q1 and Q2 quartiles, in order to guarantee the quality of the studies. Finally, 23 sources, considered essential for this bibliometric study, were obtained.

Data extraction: The 23 scientific articles, whose information was considered relevant and in accordance with the objective of the present review, were subjected to a process of reading, analysis and organization in meta-reference tables, recording relevant aspects such as authors' names, title, origin of the students, was also accompanied with the analysis of the methodology, the approach of the CCT, the research centers or Universities that developed the studies, country, year of publication, name of the journal, impact indicator, access and associated categories. Subsequently, graphs were made to present the data.

Data analysis: The tables and graphs obtained from the synthesis of the bibliometric review, allowed the identification of various features of research in CCE during the last three decades, identifying tensions and possibilities of approach from the school. In this order of ideas, the compiled and analyzed information allowed us to understand the close relationship between existing policies on CCE at the international level and the research approaches in CCE that have been developed in different countries, to contribute to the urgent need to mitigate greenhouse gas emissions and adaptation to climate change through the empowerment of young people in secondary education.

The results obtained after the bibliometric analysis of the 23 articles referred to are presented below:

Results

H1. Approach to CCD Investigations

The origin of research in CCE dates back to 1993 in England, where the first published article was traced, written by Boyes et al. (1993) from the University of Liverpool, who inquired about the greenhouse effect and global warming, recognizing the confusion regarding these environmental problems, their causes, consequences and environmental solutions (García-Rodeja Gayoso and Lima De Oliveira, 2012, p. 197).

The above research emerges one year after the Rio Summit, where the UNFCCC was established, and spurred the growth of research on topics such as environmental education and CCE. Edward Boyes and co-author Martin Stanisstreet have continued research on CCE at these educational levels, expanding the area of study to four continents.

It is highlighted that, in the three studies tracked in Malaysia, it has remained in the authorship Mageswary Karpudewan, studies have focused on "CC misconceptions" in middle school students (Karpudewan et al., 2015), experience-based CC research, fostering knowledge (Karpudewan and Mohd, 2017) and students' motivation towards the environment, examining how knowledge and psychological factors such as

beliefs and motivations, study the formation of climate conservation behavior among students from motivations and beliefs (Khan et al., 2020).

The geographical distribution of the articles included in this study is presented below.

H2. Geographic Distribution

The geographical distribution of the origin of the articles that served as sources of information in the bibliometric analysis of this research shows that the continent with the largest number of publications is America (10), followed by Asia (7), Europe (4) and Oceania (2), which can be seen in Table 1, where the corresponding countries are specified:

Table 1

Geographical distribution of items

Continent	Country	No. of publications
America	USA Brazil	1
Asia	Malaysia Singapore China India	1 1
Europa	Finland Czech Republic Sweden Spain	1 1 1 1
Oceania	Australia	
Total		

Own elaboration (2022).

Note: All information extracted from the sources was cited.

H3. Universities and Research Centers researching CCD

Table 2 below shows the main findings of the Universities and Research Centers that conducted CCT studies, highlighting that the USA is the country that hosts 43% of these institutions (9).

Table 2

Universities and Centers researching CCD

Country	Research Center / University
USA	Taos Loyola University Chicago University of Colorado Boulder North Carolina State University University of South Florida Florida Gulf Coast University University of Missouri University of California Stanford University Purdue University
Brazil	Federal Rural University of Pernambuco - UFRPE
Malaysia	Universiti Sains Malaysia
China	University of Hong Kong
India	Center for Environmental Education
Singapore	National Institute of Education Nanyang Technological University
Finland	University of Lapland
Czech Rep.	Palacky University, Olomouc
Sweden	University of Gothenburg
Spain	University of Santiago de Compostela
Australia	University of New England University of Wollongong

Own elaboration (2022).

Note: All information extracted from the sources was cited.

H4. Sources and publication trends

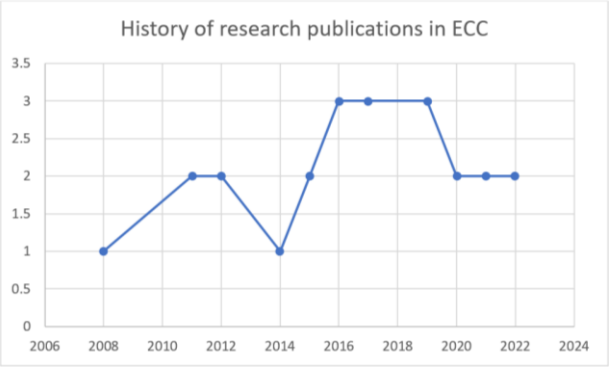
When we inquired about the sources of publication, we found 17 different journals that disseminated the 23 scientific articles consulted on ECC research in secondary education, but 39% of the research (9) was concentrated in 3 journals. At the top of the list is the "Journal of

Environmental Studies and Sciences" (4), followed by the "Journal of Geoscience Education" (3) and finally the Environmental Education Research (2).

Regarding the publication trend, it can be seen in Figure 1, that the years with the highest number of articles are 2016, 2017 and 2019, each with 3 publications. For the case of 2016, the studies were developed in China, Sweden and USA. In 2017 they were carried out in Malaysia, Singapore and USA and finally in 2019, the research originates from Czech Republic and USA. Thus, it can be stated that one of the influential factors in the spread of this research was the event of the Paris Summit COP 21 in 2015, where the member countries signed the Paris Agreement including the need to carry out these studies among young people and empower them in the face of this pressing environmental problem.

Figure 1

History of research publications in ECC



Own elaboration (2022)

Note: All information extracted from the sources was cited.

Discussion

When taking up the research question that guided the development of this article: How has climate change education been addressed in secondary school students? the results show that there is a greater concentration of research on CCE in the American continent, specifically in the USA. This finding allows us to recognize the controversies between research and the low commitment of US governments to adopt as a nation, actions aimed at reducing GHG, since it is clear that universities and research centers have maintained their interest in conducting educational research on CC and making visible the importance of the educational sector in addressing this global environmental problem. In this sense, the rupture between the voices of the educational system that researches and the governmental position and policies that follow different paths is ratified.

In thirty years of research on the educational processes of CC in MS students, it is shown that studies have focused on three lines: climate literacy, wills and behaviors of young people to act consistently for the resolution of this planetary environmental phenomenon. This approach is highly relevant, since training MS students between 15 and 17 years of age is a valid bet because of their upcoming actions as citizens of the present-future, who must be environmentally literate to opt for more responsible positions regarding GHG reduction and thus contribute to the mitigation of the planetary effect of the planetary environmental phenomenon that generates the global environmental crisis.

The research also showed that progress in CCE is not so significant, together with the absence of teacher training and clear lines in the development of their pedagogical practices for MS, which can motivate and guide CCE, in such a way that it fulfills its mitigating effect in the reduction of this phenomenon.

Conclusions

The SDG 2030 commitments to mitigate the effects of climate change, aimed at ensuring that all people throughout their lives can enjoy a wellbeing and sustainable environment, will not be met, because while the effects of climate change are increasing rapidly, education in its nature and progress, does not address the issue, nor does it focus on the foundation of citizens in training so that in the exercise of their citizenship skills and as future professionals, they have a positive action against environmental phenomena that have the planet and life in crisis.

The bibliographic search carried out indicates that, in Latin America, although there may be research on CCT for MS, it has not yet reached the highest visibility windows to be published in the SCOPUS database, which prevents them from being known by the global academic community

that guides the collection of quality information under this parameter. Furthermore, most of the research that has been carried out is in English, which is a bias for this study, as well as a limitation for accessing information and meeting the forecasts of great effects of climate change, especially for developing countries in Latin America whose native language is Spanish.

The data indicate that the approach to CCE has been scarce and although it has increased since 2015 due to the increase in guidelines issued by international organizations, with the production of guides that generate the promotion to address this global phenomenon from the school, there is no intellectual production necessary to mobilize educational research from the academy for the climate empowerment of young people in this urgent and urgent issue to be addressed.

Teachers have not been trained in the competencies necessary for the implementation and development of CCE, and CCE in turn, does not find an adequate place in the MS curriculum.

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